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| 10/673,910 | 09/30/2003 | Tsukasa Matsuda | FIS920030385US1 (RAJ-007) | 7364 |

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| EXAMINER | |
|---|---|
| STOUFFER, KELLY M | |
| **ART UNIT** | **PAPER NUMBER** |
| 1762 | |
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**Please find below and/or attached an Office communication concerning this application or proceeding.**

The time period for reply, if any, is set in the attached communication.

| Office Action Summary | Application No. | Applicant(s) | |
|---|---|---|---|
| | 10/673,910 | MATSUDA ET AL. | |
| | Examiner | Art Unit | |
| | Kelly Stouffer | 1762 | |

*-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --*

**Period for Reply**

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) OR THIRTY (30) DAYS, WHICHEVER IS LONGER, FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

**Status**

1)☒ Responsive to communication(s) filed on *20 July 2007*.

2a)☐ This action is **FINAL**. 2b)☒ This action is non-final.

3)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

**Disposition of Claims**

4)☒ Claim(s) *1-6,8-20,22,24-26,28-41,43-55,57,59-61 and 63-82* is/are pending in the application.

4a) Of the above claim(s) _____ is/are withdrawn from consideration.

5)☐ Claim(s) _____ is/are allowed.

6)☒ Claim(s) *1-6,8-20,22,24-26,28-41,43-55,57,59-61 and 63-82* is/are rejected.

7)☐ Claim(s) _____ is/are objected to.

8)☐ Claim(s) _____ are subject to restriction and/or election requirement.

**Application Papers**

9)☐ The specification is objected to by the Examiner.

10)☐ The drawing(s) filed on _____ is/are: a)☐ accepted or b)☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).

11)☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

**Priority under 35 U.S.C. § 119**

12)☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

a)☐ All b)☐ Some * c)☐ None of:

1.☐ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____.

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

**Attachment(s)**

1) ☐ Notice of References Cited (PTO-892)
2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
3) ☐ Information Disclosure Statement(s) (PTO/SB/08) Paper No(s)/Mail Date _____.
4) ☐ Interview Summary (PTO-413) Paper No(s)/Mail Date. _____.
5) ☐ Notice of Informal Patent Application
6) ☐ Other: _____.

## DETAILED ACTION

### *Response to Arguments*

1. Applicant's arguments filed have been fully considered but they are not persuasive. The applicant argues that the cited prior art does not recite features of exposing a metal-carbonyl precursor gas to receive a metal layer thickness of at least 5 angstroms in each cycle, and the applicant argues that the cited prior art does not contain this feature. However, Chung et al. in view of Lai et al. disclose that when the carbonyl precursor is thermally decomposed as taught by Chung et al., layer thicknesses of up to 300-1500 angstroms result for the metal layer (page 4 of the previous office action). In addition, Chung et al. teaches that during a cyclical deposition process, the deposition rate of the metal layer varies as a function of the metal precursor (column 10 lines 9-25), showing that it would be obvious to modify this variable by routine experimentation. Therefore, these arguments are not convincing and the rejections from the previous office action are maintained.

### *Claim Rejections - 35 USC § 103*

The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

> (a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

The factual inquiries set forth in *Graham* **v.** *John Deere Co.*, 383 U.S. 1, 148 USPQ 459 (1966), that are applied for establishing a background for determining obviousness under 35 U.S.C. 103(a) are summarized as follows:

1. Determining the scope and contents of the prior art.
2. Ascertaining the differences between the prior art and the claims at issue.
3. Resolving the level of ordinary skill in the pertinent art.
4. Considering objective evidence present in the application indicating obviousness or nonobviousness.

This application currently names joint inventors. In considering patentability of the claims under 35 U.S.C. 103(a), the examiner presumes that the subject matter of the various claims was commonly owned at the time any inventions covered therein were made absent any evidence to the contrary. Applicant is advised of the obligation under 37 CFR 1.56 to point out the inventor and invention dates of each claim that was not commonly owned at the time a later invention was made in order for the examiner to consider the applicability of 35 U.S.C. 103(c) and potential 35 U.S.C. 102(e), (f) or (g) prior art under 35 U.S.C. 103(a).

2. Claims 1-6, 8-15, 17-20, 22, 24-26, 28-41, 43-50, 52-55, 57, 59-61, 63-74, and 75-82 are rejected under 35 U.S.C. 103(a) as being unpatentable over US Patent publication 2003/0203616 A1 to Chung et al. in view of US Patent 6939804 to Lai et al.

Regarding claim 1, Chung et al. discloses a method of depositing a metal layer on a substrate by providing a substrate to a process chamber and performing a deposition cycle until the thickness of the metal film is greater than 5 A by exposing the substrate from a metal-carbonyl and reducing gas (paragraphs 0030-0034 et seq and

paragraph 0046). Lai et al. includes a similar process, but also teaches that the metal carbonyl, or tungsten containing precursor, may be formed by thermally decomposing the precursor in a CVD process, which would imply that the substrate is at a temperature to achieve this (column 2 lines 1-20). Figure 8A of Lai et al. shows that the film thickness is a function of precursor exposure time. Precursor exposure in Lai et al. is modified depending upon the equipment used and thickness desired (column 6 lines 37-55). Also, when using a CVD process to deposit the tungsten carbonyl precursor to receive tungsten metal, a film thickness of 300-1500 angstroms is achieved (column 9 lines 55-65). One of ordinary skill in the art would want to use the CVD thermal decomposition to deposit the tungsten carbonyl compound in Chung et al. as taught by Lai et al. because more than a monolayer can be deposited and the amount of gas pulses needed and complexity of the process would lessen, as is suggested by both references. Also, as one of ordinary skill in the art would recognize, depositing the material by thermal decomposition would give a first layer of greater adherence to the substrate, which would be beneficial to both Chung et al. and Lai et al. In addition, one of ordinary skill in the art would be motivated to pulse a reducing gas even after the tungsten is deposited by CVD as taught by Chung et al. because pulsing the reducing gas allows for complete conversion to tungsten metal from tungsten carbonyl and ensures the desired film properties (paragraph 0033 of Chung et al.) As taught by both references, cyclic deposition processes are beneficial to deposit layers of desired thickness in a controllable manner.

Referring to claims 2 and 3 Chung et al. discloses the precursor as $W(CO)_6$ and the metal layer as tungsten in the abstract and paragraph 0026.

Chung et al. and Lai et al. include all of the requirements of claims 4 and 39 as discussed above except having a precursor gas flow less than 4 sccm. Chung et al. teaches that process conditions, such as precursor pulse rate, are advantageously selected so that a pulse of the tungsten carbonyl provides a sufficient amount of compound so that at least a monolayer of the material is adsorbed on the substrate (paragraph 0031). The variable of precursor gas flow is thus dependant on process conditions and is a result effective variable with its modification done with routine experimentation.

It would have been obvious to one of ordinary skill in the art at the time of the invention to modify Chung et al. and Lai et al. to include the precursor flow as less than 4 sccm by routine experimentation in order to deposit at least a monolayer of material on the substrate absent evidence showing a criticality for the claimed values.

Referring to claims 5-6 Chung et al. discloses the precursor gas comprising a carrier gas or dilution gas (one of ordinary skill in the art would recognize that a gas carrying a reactive gas would also dilute it) that is Ar, He or nitrogen in paragraph 0029.

With regard to claims 8-12, Chung et al. discloses the flow rates of the precursor to be between 10-400 sccm and the carrier, or diluent, gas with the precursor having a flow rate of 150-2000 sccm.

Regarding claims 13 and 15, Chung et al. discloses the reducing gas to be a boron containing gas, specifically $BH_3$, $B_2H_6$, or $B_3H_9$ in paragraph 0027.

With regard to claims 14 and 49, Chung et al. does not include the reducing gas as silane, disilane or dicholorsilane. Lai et al. teaches the reducing gas as silane, disilane, or dichlorosilane in addition to borane containing gases in column 6 lines 63-65 in order to provide alternatives to borane as suggested by Lai et al.

It would have been obvious to one of ordinary skill in the art at the time of the invention to modify Chung et al. to include the reducing gas as a silane as taught by Lai et al. in order to provide alternatives to borane reducing gases.

Regarding claims 17-20, and 22 Chung et al. discloses the reducing gas to have a flow of between 5-150 sccm lasting for less than 2 seconds with a dilution or carrier gas comprising Ar with a flow rate between 250-1000 sccm in paragraph 0045.

Regarding claims 24-26, the metal carbonyl and reducing gas are pulsed sequentially into the chamber with a purge gas flowing in between pulses comprising Ar, He or nitrogen in paragraphs 0029-0033.

With regard to claim 28, the purge gas in continuously flowed in paragraph 0029.

With regard to claims 29-31, the purge gas is flowed at least before exposing the metal layer to borane (paragraph 0032) for 1000 sccm for 1 second (paragraph 0046).

With regard to claims 32-33, the substrate temperature is between 150-350 °C and the chamber pressure is from 0.5 to 10 torr in paragraph 0045.

Chung et al. includes all the provisions of claims 34-35, 71-72, and 75-82 as discussed above except for claimed values of layer thickness during one deposition cycle. Lai et al. teaches that the deposition rate per cycle varies as a function of pulse time in column 10 lines 14-25. Lai et al. also teaches that deposition rate per cycle is only important to deposit a desired thickness for a preferred application for the layer and to determine the number of cycles one would use to deposit this final desired thickness (column 8 lines 28-37).

It would have been obvious to one of ordinary skill in the art at the time of the invention to modify Chung et al. to include the claimed values of deposition rate per cycle by routine experimentation as taught by Lai et al. in order to deposit a layer of desired thickness for a preferred application and to determine the number of cycles one would use to deposit this final desired thickness absent evidence showing a criticality for the claimed values.

Regarding claims 36 and 37, the substrate is a semiconductor (abstract) comprising silicon oxide, among others, in paragraphs 0048-0049.

The recitations of claims 38, 40-41, 43-48, 50, 52-55, 57, 59-61, 63-69, and 73-74 are met by Chung et al. and Lai et al. as discussed above.

Chung et al. and Lai et al. include all the provisions of claim 70 as discussed above except a pressure of 0.2 torr in the process chamber. Chung et al. teaches that the chamber conditions such as pressure are adjusted only to enhance the adsorption of process gases on the substrate (paragraph 0028). Therefore, modification of the process chamber values is by routine experimentation and is not inventive.

It would have been obvious to one of ordinary skill in the art at the time of the invention to modify Chung et al. and Lai et al. to include a chamber pressure of 0.2 torr by routine experimentation in order to enhance the adsorption of process gases on the substrate absent evidence showing a criticality for the claimed value.

3. Claims 16 and 51 are rejected under 35 U.S.C. 103(a) as being unpatentable over Chung et al. and Lai et al. in view of US patent publication 2002/0187256 A1 to Elers et al. Chung et al. and Lai et al. do not include the reducing gas as comprising $NH_3$. Elers et al. teaches the reducing gas as comprising $NH_3$ in addition to borane

containing gases in paragraphs 0078-0080 in order to provide alternatives to borane as suggested by Elers et al.

It would have been obvious to one of ordinary skill in the art at the time of the invention to modify Chung et al. and Lai et al. to include the reducing gas as comprising $NH_3$ as taught by Elers et al. in order to provide alternatives to borane reducing gases.

***Conclusion***

Any inquiry concerning this communication or earlier communications from the examiner should be directed to Kelly Stouffer whose telephone number is (571) 272-2668. The examiner can normally be reached on Monday - Thursday 7:00-5:30.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Timothy Meeks can be reached on (571) 272-1423. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see http://pair-direct.uspto.gov. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free). If you would like assistance from a USPTO Customer Service Representative or access to the automated information system, call 800-786-9199 (IN USA OR CANADA) or 571-272-1000.

Kelly Stouffer
Examiner
Art Unit 1762

kms

BRET CHEN
PRIMARY EXAMINER